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### **Method and device for an ad hoc network with mobile subscribers**

The essential feature of the invention is that, due to the active incorporation of the travel status data of the surroundings, and by means of static traffic flow data, dynamic traffic flow data, topographical information and topological information, connection paths are set up predictably in such a way that the network structure, despite high subscriber fluctuation, becomes as stable as possible and therefore, due to the smaller number of connection changeovers, the transmission quality or bandwidth is improved.

**[0001]** The invention relates to dynamic networks which are created in that, for example, vehicles set up connections by means of radio technology. The vehicles envisaged are primarily road-based vehicles, for example motor cars, but may also involve ships or even aircraft. However, mobile ad hoc networks of this type are subject to very substantial changes in terms of their networking, as a result of high subscriber fluctuation caused by vehicles which are normally moving towards different destinations and in different directions.

**[0002]** Attempts to improve transmission quality have hitherto been made only in terms of improving the radio characteristics and the data to be transmitted.

**[0003]** Basic principles for networks of this type can be found, for example in the book by Perkins, Charles E.: "Mobile IP", Design Principles and Practices; Addison-Wesley Longman, Amsterdam, 1998.

**[0004]** The object of the invention is to indicate a method and a device for an ad hoc network with mobile subscribers in which, with a fixed predefined bandwidth, improved transmission quality or, with the same transmission quality, a lower transmission bandwidth is required.

**[0005]** This object is achieved according to the invention in terms of the method by the features of claim 1 and in terms of the device by the features of claim 7. The further claims relate to advantageous further developments of the method.

**[0006]** The essential feature of the invention is that, due to the active incorporation of the travel status data from vehicles in the surroundings, and by means of static traffic flow data, dynamic traffic flow data, topographical information and topological information, connection paths are set up predictably in such a way that the network structure, despite high subscriber fluctuation, becomes as stable as possible and therefore, due to the smaller number of connection changeovers, the transmission quality or the use of the predefined bandwidth is improved.

**[0007]** Embodiments of the invention are explained in detail below with reference to the drawing.

**[0008]** The drawing shows an example of a section of an ad hoc network for mobile subscribers, in which a connection can be set up from a mobile node A to a further mobile node B either via an adjacent mobile node H1 or a further adjacent mobile node H2 (hop), whereby these nodes represent switching nodes (hops) and, in the switching node H2, forwarding is performed either via a switching node H21 or via a switching node H22 to the destination node B. The adjacent mobile node H1 transmits its travel status data, for example its position, general acceleration data, direction, destination, driver profile, etc. to the mobile node A. This is also performed in a corresponding manner from the mobile switching node H2, which transmits its travel status data D2 to the node A.

**[0009]** The data D1 or D2 can be transmitted from the adjacent nodes to the originating node A, for example, by simply streaming these data with a specific range on specific frequencies only, whereby the information is available for evaluation to all receivers located in the vicinity. However, it is also conceivable for the travel status data to be forwarded via a specific number of switching nodes or intelligently, depending on the distance, simply through broadcasting or multicasting in the network.

**[0010]** In creating these ad hoc networks, the decision is in each case left open regarding the adjacent node with which a link is set up, or regarding the link via which data are routed/forwarded. In addition to this information, the mobile node A receives additional information on its surroundings and/or the surroundings of its adjacent mobile nodes from a local memory located in the node A, or it receives up-to-date additional information, for example from a traffic control centre VL, which is, for example, streamed via a geographically fixed transmitting station or offered as a service in the network.

**[0011]** Probable future changes in the quality of transmission to the respective adjacent node are determined from the travel status data D, D1 and D2 with the aid of the additional information in the node A, as explained in detail below, and a connection is set up to forward information via the adjacent node via which the probable future changes in the transmission quality are best.

**[0012]** The additional information may be as follows:

1. Static traffic flow data which has been derived from statistical mean values from measured traffic flows in the past. A traffic flow of this type either has only an amount, or, in addition, a direction. Thus, it is possible, for example, to take account of the fact that continuous movement of the mobile nodes on extensive roads, for example motorways, is greater than on secondary roads, and therefore a routing structure can be kept more stable than on secondary roads.

2. Dynamic traffic flow data:

Since the normal traffic flow situation is significantly changed by traffic jams or accidents, dynamic traffic flow data, for example, which originate, for example, from a traffic control system and are streamed within a specific range area, can be used optionally as up-to-date additional information.

3. Topological information:

Topological information in the form of town plans or road maps can also be used optionally as additional information. By means of this information and the travel status information D, D1 and D2, it is possible to establish, for example, whether the

adjacent mobile nodes or vehicles will probably travel in future along the same carriageway, along a side road, or along the opposite carriageway. In the case of the same carriageway, the routing structure can be assumed to be more stable than in a situation in which the adjacent node moves away along a side road or, in an even worse case, along the opposite carriageway.

#### 4. Topographical information:

Topographical information can also be used optionally as additional information for the evaluation. Consideration must be given here, for example, to probable changes in terrain for the mobile node in its surroundings, or obstacles, for example in the form of buildings and tunnels. It is assumed here that the routing structure, due to these changes in terrain or due to shadowing caused by buildings or tunnel entrances, cannot be kept stable to the same extent as in the case of switching via switching nodes moving along open terrain.

[0013] In the mobile node A, probable future changes in the quality of transmission to the respective adjacent node are determined from the travel status data of the adjacent mobile nodes H1 and H2 and the additional information, and a connection is set up via the adjacent node via which the probable future changes in transmission quality can best take place.

[0014] Selection mechanisms of this type are conceivable not only in the originating node A, but also in downstream switching nodes, for example the node H2 with its adjacent nodes H21 and H22.

[0015] It is furthermore conceivable that the node A is supplied not only with the travel status data of the adjacent mobile nodes, but also the travel status data of a plurality or all switching nodes located in the respective transmission paths, for example H21 or H22, and these are also taken into account in forming the outgoing transmission paths from the node A.

[0016] It should be noted here that the means required to form a corresponding device can be implemented in the form of hardware and/or software.

## Claims

1. Method for an ad hoc network with mobile subscribers, in which at least one mobile node (A) of the network receives the respective travel status data (D1, D2) from at least one adjacent mobile node (H1, H2),  
in which the at least one mobile node retrieves or receives additional information on its surroundings and/or the surroundings of the at least one adjacent mobile node from its local memory,  
in which future changes in the quality of transmission to the respective adjacent node are determined from the travel status data (D, D1, D2) of the mobile node itself and the adjacent nodes with the aid of the additional information, and  
in which a connection is set up to forward information via the adjacent node via which the probable future changes in the transmission quality are best.
2. Method according to claim 1, in which the respective additional information is determined as the probable traffic flow depending on the position of the respective mobile node, and the respective probable changes in transmission quality are determined in such a way that the connections to adjacent nodes with high probable traffic flow values are preferred.
3. Method according to claim 2, in which the traffic flow is retrieved statically in the form of a respective probable traffic flow from a local memory provided in the mobile node.
4. Method according to claim 2, in which the probable traffic flow is determined depending on information from a traffic control system (VL).
5. Method according to one of the preceding claims, in which additional information is provided as topological information in the form of a road map, and the respective probable future changes in transmission quality are determined in such a way that connections to adjacent mobile nodes on the same carriageway are given a higher probability of good transmission quality than connections to mobile nodes which turn off into a side road, and these in turn have a higher probability of good transmission quality than connections to mobile nodes travelling along the opposite carriageway.

6. Method according to one of the preceding claims, in which additional information is available as topographical information and the respective probable future changes in transmission quality are determined in such a way that connections to adjacent mobile nodes which have a high probability of changes in terrain and/or obstacles in their surroundings adversely affecting the connection are given a lower probability of good transmission quality than in the case of low probability of changes in terrain and/or no or few obstacles.

7. Device for an ad hoc network with mobile subscribers, in which at least one mobile node (A) is provided, containing the following means:

- a) Means to receive travel status data from at least one adjacent node,
- b) Means to store and/or receive additional information on its surroundings and/or the surroundings of the at least one adjacent node,
- c) Means to determine respective probable future changes in the quality of transmission to the respective adjacent node, and
- d) Means to set up a connection between the mobile node and the adjacent node offering the best probable future changes in the transmission.